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Remarks

Thorough examination and careful review of the application by the Examiner is noted and appreciated. Applicants respectfully request Examiner to allow entry of the amended claims to either place the claims in condition for allowance or in better form for appeal.

The Abstract has been amended and a replacement paragraph presented on a separate page as required under revised amendment practice according to 37 CFR 1.121.

The drawings have been amended to correctly designate the photoresist layer as 16 consistent with the Specification.

The Specification was inadvertently changed in the previous office action in paragraph 0042 due to reference to a pre-filed version of the Specification and has been amended as correctly pointed out by the Examiner to be consistent with the originally filed Specification.

The claims have been amended to more clearly claim Applicants invention and attempt to address Examiner's concerns and overcome Examiners objection and rejections.

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Support for the new limitations in the amended claims is found in the original claims and the specification. No new matter has been entered.

Claim Objections

Applicant has amended claim 11 to overcome Examiners objection.

Applicant has cancelled claims 25 and 26 to overcome Examiners objections.

Claim Rejections under 35 USC 112 2d paragraph

Claim 11 has been amended to overcome Examiners rejection.

Applicants respectfully suggest that Examiner is impermissibly reading limitations into claim 15 from the Specification. Applicants suggest that Claim 15 is not unclear as written in Markush claim format. It is clear according to Markush claim interpretation that the first and second ARC layers may be composed of the same material as disclosed and claimed in original claim 15 and the Specification at paragraph 0034:

"The material of the ARC is selected depending on the wavelength of the light source used during the

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photoresist exposure step for the damascene patterning. For example, titanium nitride (TiN) is a preferable ARC material for an I-line source, and silicon oxynitride (SiON) is preferable for a deep ultra-violet (DUV) source."

See also the original claims e.g., claims 15 which refers to the conformal ARC layer and the Specification at paragraph 0036 which refers to the first ARC layer (prior to forming the via openings) :

"Alternatively, the etching stop layer 28 may include silicon nitride and the ARC 26 may include silicon oxynitride. In another embodiment, the ARC 26 may include titanium nitride."

Therefore it is clear that Applicant has sufficient support in the specification for claiming either the first or second ARC layer or both may be formed of silicon oxynitride or titanium nitride consistent with the interpretation of the Markush claim format in claim 15.

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However, in order to further prosecution, Applicant has amended claim 15 and added new claim 27 to further clarify the claimed invention.

Claim Rejections under 35 USC 103(a)

Claims 1-3, 7, 10-11, 13-15, 17-24 stand rejected under 35 USC 103(a) as being unpatentable over Lin et al., in view of Yu et al. (US Pat.No. 6,027,861) and further in view of Filipiak et al. (US Pat. No. 5,918,147).

Lin et al. teach a dual damascene process by filling a via opening with protective material prior to patterning an overlying trench in a dual damascene process (see Abstract). The protective material serves to protect the exposed material at the bottom of the via opening during a subsequent overlying trench etching process (see e.g., col 6, lines 10-14). Lin et al. teach first forming a via opening portion (see e.g., col 4, lines 55-67, col 5, lines 20-25). After removing the via pattern resist layer, Lin et al. teach depositing a protective material disclosed to be a BARC layer e.g., silicon oxynitride or an organic material to fill the via opening, (see e.g., col 5, lines 35-57, Figure 2C). Lin et al. then teach removing a portion of the protective material from the filled via opening to about a

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level of an intervening etch stop layer following patterning of the overlying trench. The protective material is first etched back followed by etching of the overlying trench or simultaneously etched back with the trench etching. (see col 5, lines 57-65 and col 5, lines 1-14).

Examiner admits that Lin et al. do not disclose an ARC layer as claimed by Applicants in claim 1:

"forming an antireflectance coating (ARC) layer over the IMD layer such that the ARC layer is formed over sidewalls of the at least one via opening without filling the at least one via opening; and,

depositing a photoresist layer over the IMD layer and photolithographically patterning a trench opening over the at least one via opening."

Lin et al., further do not teach or disclose forming a first ARC layer over the IMD layer prior to forming via openings followed by forming a second ARC layer to cover via opening sidewalls without filling the at least one via opening as claimed by Applicants in amended claim 11.

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Lin et al. further do not teach forming an etch stop layer (e.g., second dielectric layer) underlying the first ARC layer prior to forming a via opening followed by substantially conformally depositing a second ARC layer to cover via opening sidewalls as claimed by Applicants in amended dependent claim 13 and amended independent claim 20.

Examiner argues that the disclosed properties of the single ARC layer formed to fill the via opening taught by Lin et al. "hint at the usefulness of a second underlying ARC" as claimed by Applicants in dependent claims claim 11.

Examiner also argues that "it is readily apparent that that adequate protection" to the via opening according to the method of Lin et al. "could be obtained using one or more ARC layers of sufficient thickness without necessarily requiring that the ARC material fill one or more via openings or holes". Applicants respectfully suggest that Examiner is engaged in classic hindsight reasoning, recreating Applicants claimed invention from Applicants specification and recognition of a problem Applicants have solved by their claimed invention. Lin et al. neither suggest, disclose, or hint at Applicants claimed invention and do not recognize the problem Applicants have recognized and solved

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by their claimed invention. Indeed, Lin et al. affirmatively teach away from Applicants claimed invention by requiring either a separate or simultaneous etching step to remove a portion of the protective material during etching an overlying trench. The principal of operation of Lin et al. is completely different than the principal of operation of the method of Lin et al.

Examiner points for support for his argument to the discussion of the prior art where a dual damascene is made according to an entirely different process as claimed and disclosed by Applicants; where the trench opening is first patterned and partially etched followed by patterning and etching the underlying via portion (see e.g., Figures 1A-1F and col 1, lines 49-62). Lin et al, note that the prior art has disadvantages such as poorly defined edges of the via portions in the lower half due to the effect of the first trench etching and second via etching on the upper trench portion (see col 1, line 63 - col 2, line 7). The prior art teaches forming a thin via mask to line the first etched trench opening prior to etching the underlying via opening to protect the subsequently formed via edges (see e.g., Figures 1C through 1G). Following etching of the underlying via, the protective thin layer remains covering the first etched trench portion (see col 2, lines 58-64, Figure 1G).

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Lin et al. neither suggest, disclose or hint at the desirability of forming an ARC layer to line a first etched via opening portion prior to patterning an overlying trench as disclosed and claimed by Applicants. Neither Lin et al. nor the prior art recognize the problem that Applicants have recognized and solved. The thin via mask disclosed in the prior art for protecting via edges while etching an underlying via serves a completely different purpose in the context of a completely different method for forming a dual damascene. Examiner is impermissibly re-creating Applicants disclosed invention by hindsight reasoning and can point to no suggestion, hint, or desirability in Lin et al. for doing what Applicants have accomplished by their claimed invention.

"First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's

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disclosure." *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

"If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious." *In re Ratti*, 270 F.2d 810, 123, USPQ 349 (CCPA 1959).

Yu et al. teach a method for etching sub-quarter micron openings in dielectric insulating layers by using a thin layer DUV photoresist (see Abstract). In one embodiment, Yu et al. disclose forming a via opening for filling with a tungsten plug by using a Ti/TiN etching hardmask which also functions as an ARC layer for etching the via opening (col 4, lines 58-62). The via is then etched with the Ti/TiN layer hard mask providing high selectivity for etching the insulating layer (col 6, lines 19-24).

Yu et al. does not suggest disclose or suggest depositing an ARC layer to fill the via opening as taught by Lin et al., nor disclose or suggest forming an ARC layer formed over sidewalls of a via opening without filling the via opening prior to patterning

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an overlying trench portion in a dual damascene process as claimed by Applicants.

There is no apparent reason for combining the teachings of Yu et al. with Lin et al. However, even assuming arguendo legitimate motivation exists for combining Yu et al. and Lin et al., such combination does not produce Applicants claimed invention. Applicants reiterate that the disclosure of Yu et al. in forming a Ti/TiN hardmask layer that also functions as an ARC layer does not help Examiner in making out a *prima facie* case of obviousness with respect to Applicants claimed invention. Applicants do not disclose or claim a Ti/TiN layer but rather disclose a TiN ARC layer as one element of a Markush group for forming a first or second ARC layer. Yu et al. do not discuss, disclose or suggest the desirability of depositing an ARC layer to cover the via opening sidewalls without filling the via opening prior to a trench patterning process overlying the via.

Filipiak et al. generally discloses types of ARC layers such as silicon oxynitride and titanium nitride in the background of the invention (see col 1, lines 10-20) as well as teaching the use of multiple ARC layers including forming inorganic ARC layers, e.g., silicon oxynitride with a continuously graded

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composition or including a plurality of discrete portions that make up the antireflective layer (see col 2, lines 17-27, col 3, lines 21-30). There is no apparent motivation for combining Filipiak et al. with either Yu et al. or Lin et al. For example Filipiak et al. disclose the use ARC layers **prior to** etching via openings, and further, do not disclose a dual damascene process.

Nevertheless, assuming arguendo, a proper motivation for combining the references, such combination does not produce Applicants disclosed and claimed invention. Neither Lin et al., Yu et al., nor Filipiak et al. disclose or suggest forming an ARC layer over sidewalls of a via opening without filling the via opening to reduce light reflection in a subsequent overlying trench patterning process. In addition, neither Filipiak et al., nor any combination with Yu et al. or Lin et al. disclose or suggest forming a first ARC layer overlying an IMD (insulating) layer prior to forming a via opening followed by conformally depositing a second ARC layer to cover via opening sidewalls prior to patterning an overlying trench as disclosed and claimed by Applicants.

Examiner argues that "it would also have been obvious to apply at least one thin conformal ARC layer to the sidewalls of

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the holes or openings without filling the holes or openings before patterning an overlying resist layer to avoid reflective notching of the photoresist, as taught by Lin and disclosed by Filipiak"

Examiner is mistaken that Lin et al. teach such a process or that Filipiak discloses such a process. Neither Lin et al. nor Filipiak et al. disclose, hint, or suggest forming an ARC layer over sidewalls of a via opening without filling the via opening prior to a trench patterning process to reduce light reflection in the trench patterning process, a problem recognized, disclosed and claimed by Applicants. Lin et al. teach filling the via opening with a protective material to protect the via bottom portion in a subsequent trench etching process. Filipiak et al. teach forming a multiple graded ARC layers over an insulating layer prior to etching interconnect (e.g., via) openings (see col 5, lines 14-40) and do not disclose a dual damascene process. The method of Filipiak et al. has little relevance to forming a dual damascene structure as disclosed and claimed by Applicants.

Neither Lin et al., Yu et al., nor Filipiak et al. recognize teach or suggest the problem that Applicants have recognized and solved by their claimed invention. Applicants disclosed and

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claimed invention recognizes and solves the problem of light reflections from via sidewalls to undercut a resist layer in a trench patterning process, without having to fill the via with a protective material and engage in a separate etchback process as in the method of Lin et al. The fact that Yu et al. disclose a Ti/TiN ARC layer, and the fact that Filipiak et al. disclose a graded composition ARC layer, or multiple ARC layers, including silicon oxynitride and titanium nitride, even assuming arguendo proper motivation to combine the teachings of the cited references, fails to produce Applicants claimed invention and the teachings are insufficient to make out a *prima facie* case of obviousness.

"We do not pick and choose among the individual elements of assorted prior art references to recreate the claimed invention, but rather we look for some teaching or suggestion in the references to support their use in a particular claimed combination" *Symbol Technologies, Inc. v. Opticon, Inc.*, 935 F.2d 1569, 19 USPQ2d 1241 (Fed. Cir. 1991).

The Claims have been amended to clarify Applicants' invention and newly drafted claims added. A favorable consideration of Applicants' claims is respectfully requested.

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Based on the foregoing, Applicants respectfully submit that the Claims are now in condition for allowance. Such favorable action by the Examiner at an early date is respectfully solicited.

In the event that the present invention as claimed is not in a condition for allowance for any other reasons, the Examiner is respectfully invited to call the Applicants' representative at his Bloomfield Hills, Michigan office at (248) 540-4040 such that necessary action may be taken to place the application in a condition for allowance.

Respectfully submitted,

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